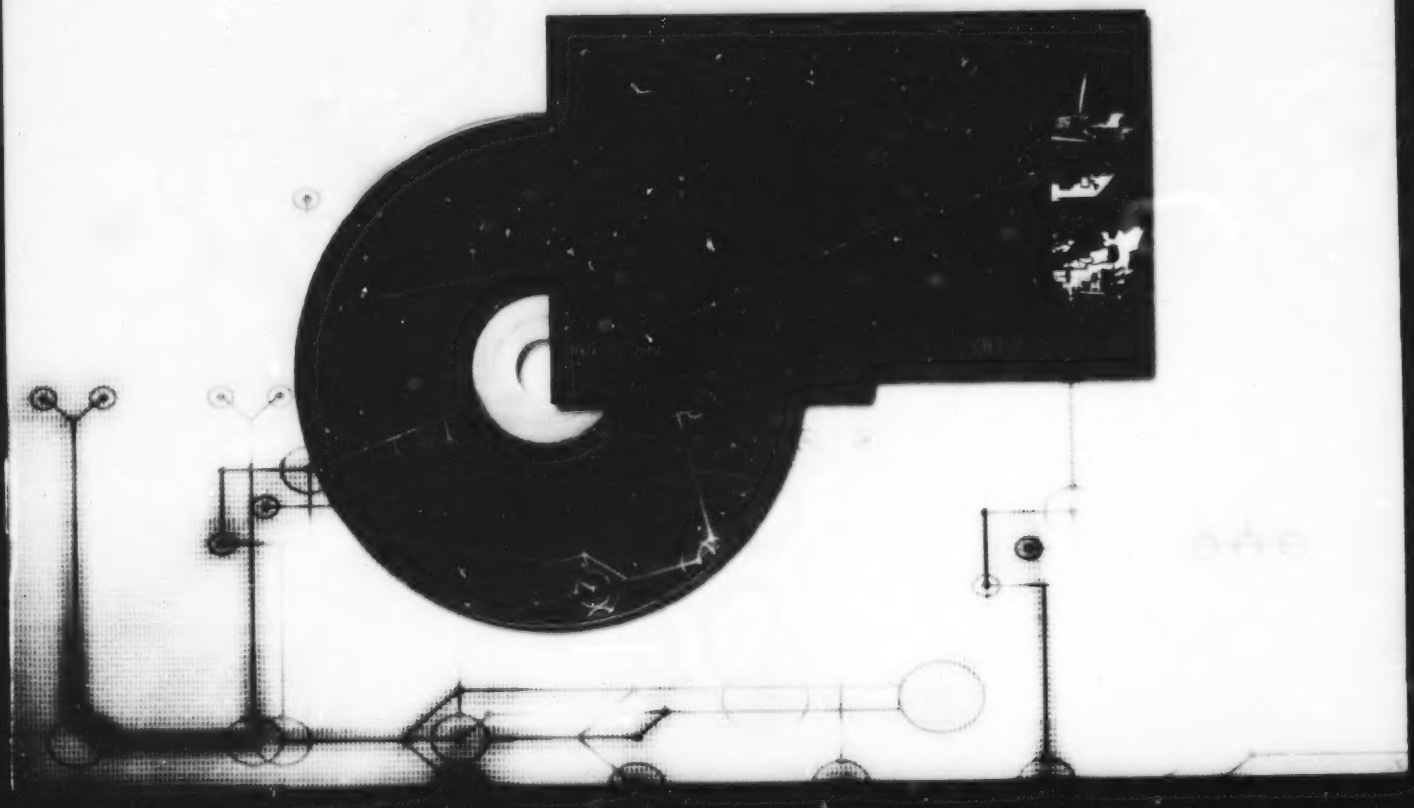
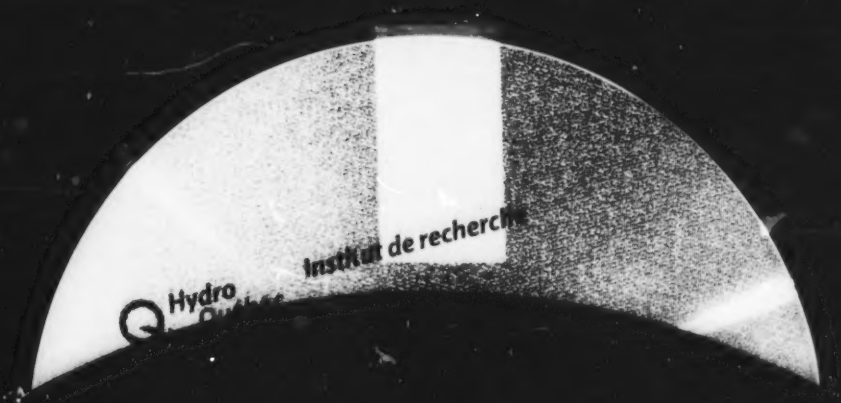
Hydro Québec

Institut de recherche

Research-Development & Testing

2000-2002

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Research-Development & Testing

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The mission of the research institute, which is at the core of technological innovation at Hydro-Québec, is to conduct research, development and testing and to favour the development and implementation of new technologies that allow the company to provide its customers with reliable, "green" energy at the least cost

The choice to innovate

Hydro-Québec has chosen to innovate. It would like to put to use its best electrical power generation technologies, incorporate the latest scientific developments into its transmission and distribution activities, and help customers use energy as efficiently and cost-effectively as possible.

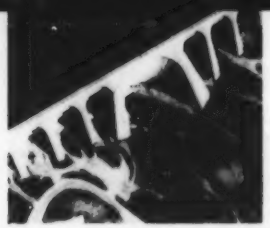
To ensure that this choice takes the form of true technological innovation that is implemented in the field, Hydro-Québec has made innovation part of an integrated approach where researchers from its research institute, future users of innovation products and its technology development experts interact together. They lend their expertise to all stages of project development, during the actual research phase as well as during development, commercial production, certification, network integration and commercialization, as the case may be. As a key element of this approach which favours targeted, structuring and coherent technological projects that are strictly geared to meeting the company's strategic and business needs, R&D thus becomes a major economic and competitive issue, and in so doing its strategic nature is reaffirmed.

A more rigorous management of the portfolio of projects, teams, budgets and timetables ensures a rapid and systematic assessment of the technical and scientific excellence of the solutions proposed by R&D, as well as an estimate of the potential gains, costs, lead times and technical feasibility. Furthermore, by emphasizing technological development and the participation of risk venture experts, this steps up the validation and evaluation of the outside potential of ideas based on the clients, competition and financial prospects. Finally, through the involvement of Hydro-Québec's divisions and partners, the process facilitates the implementation or marketing of new technologies while ensuring that projects which hold little promise for the company are quickly shelved.

Firmly backed by Hydro-Québec's senior management, the innovation process orients R&D toward a more relevant and higher quality research as a result of the quality of the expertise involved and the willingness of those who together carry it out to deliver the significant financial gains which the company expects.

Jacques G. Martel
Managing Director, Institut de recherche

Hydro-Québec has rigorously reevaluated its R&D activities in order to draw up a series of themes that encompass areas of research where the most important challenges related to its core activities must be met. In the area of generation, the company seeks to innovate by developing new construction concepts and improving the cost-effectiveness and service life of its installations. On the transmission front, innovation is geared toward increasing the life span of its installations and reducing maintenance costs related to the network and new installations. Innovating in this area will also mean increasing the load flow capacity, optimizing network management and decreasing the impact of major climatic events. In the area of distribution, innovation is related to improving the quality of the power supply and reducing the cost of the underground and overhead networks. Innovation projects which target customers will involve developing new sales in industrial markets, maintaining the profit margin of sales in commercial and institutional markets, and in reducing procurement costs and increasing the satisfaction of residential customers.



Generation

- Developing new construction concepts
- Increasing the cost-effectiveness and service life of installations

Transmission

- Increasing the service life of equipment
- Reducing network maintenance costs
- Increasing the load-flow capacity
- Optimizing network management
- Decreasing the impact of major climatic events

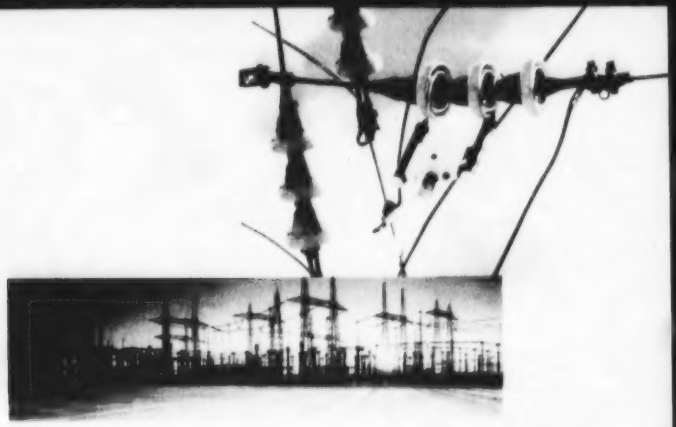
Distribution

- Improving the quality of the power supply
- Reducing underground and overhead network costs

Customers

- Developing new sales
- Reducing procurement costs
- Increasing customer satisfaction

A corporate research centre fully



Integrated management

To implement the new approach, Hydro-Québec has set up platform teams in the strategic areas of generation, transmission, distribution and customer services. Jointly led by a member of senior management from the Hydro-Québec division involved and the vice president of research and strategic planning, each team includes an operational core made up of a representative of the research institute, the technology development division and the business unit involved. Based on proposals made by researchers, they then draw up portfolios of innovation projects to be carried out within three to five years. Their mandate is to lead the process and manage innovation investments to maximize their economic impact. The teams ensure that the work remains relevant and to some extent set the innovation objectives.

Strategic innovation

Strategic innovation complements the portfolios of innovation projects in generation, transmission, distribution and customer services. In fact, while the latter deal with Hydro-Québec's technology needs over the short term (a few years), strategic innovation activities, for their part, are geared to meeting the company's technological objectives and needs over a 10-year timeframe.

Their aim is to evaluate and forecast, based on different technological, economic, market-based and climatic indicators, various scenarios which are not necessarily a projection of the company's current situation but which are likely to have a major impact on its operations, business practices or base competencies.

Our analysis and review work is backed by the expertise of specialists from Hydro-Québec, the research institute and outside experts as well as the results of activities carried out within international organizations. They will orient R&D efforts and investments in order to develop high-tech technologies or implement methods and approaches that will meet future needs. These are activities that will eventually be included in the portfolios of innovation projects.

Discussions with the scientific community, specialists from Hydro-Québec's divisions and outside experts led to the design of a technological road map for the company. As a result, five long-term objectives which will consolidate the company's position as a North American leader in the energy industry were devised. The objectives and technological avenues are as follows:

Actively managing our network in real time to optimize commercial exchanges of energy

- Controlling and increasing the load flow
- Developing probabilistic risk management models

Controlling the effects of climate change on runoff, demand and our installations

- Forecasting long-term fluctuations in runoff
- Forecasting runoff over the short and medium terms
- Monitoring climatic change and its impact on factors other than runoff

Improving the efficiency of the power system from generation to end use

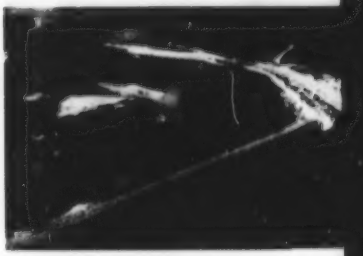
- Increasing the output of generating facilities
- Decreasing system losses
- Promoting clean electrotechnologies

Benefiting from decentralized generation

- Characterizing the potential of decentralized generation to increase production
- Integrating distributed generation into the grid

Extending the limits of our transmission system

- Increasing cost-effective transmission capabilities threefold
- Separating supply from demand

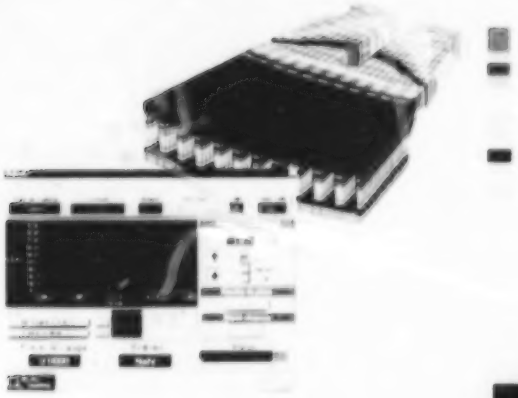


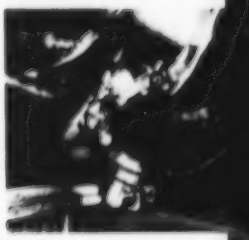
Expertise

The most competent resources are put to use to carry out the portfolios of innovation projects. The research institute's research scientists, leading specialists in mechanical, metallurgical and civil engineering, electrical equipment, power system analysis, operation and control, chemistry and materials, and applications of energy, lend their expertise to carry out innovation projects.

Outstanding expertise in the areas of:

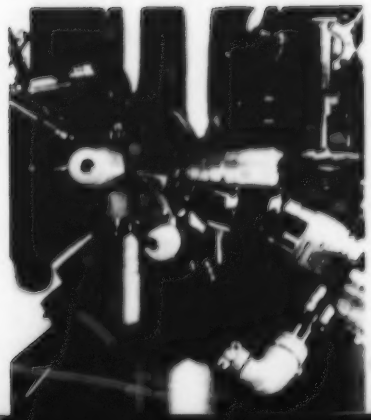
- Mechanical, metallurgical, civil engineering
- Electrical equipment
- Power system analysis, operation and control
- Automation and measurement systems
- Chemistry and materials
- Applications of energy





Project management

As accomplished researchers or renowned experts within Hydro-Québec's various divisions, the project managers can count on being backed by powerful and sophisticated project management tools. In fact, the team led by the project administrator provides the necessary services and systems and manages the budgets. The administrator acts as a "trustee" for the budgets granted by the platform teams to carry out innovation projects. He is in charge of the project accounting and administration as well as for budget control and follow-up.

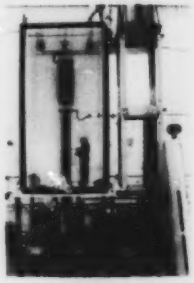


The research institute also comprises testing laboratories – high-voltage, high-power, mechanical and thermo-mechanical, power-system simulation – along with field-testing and calibration units. Most of the laboratories have received ISO/IEC 17025 accreditation and continue to meet Hydro-Québec's requirements with respect to innovation.

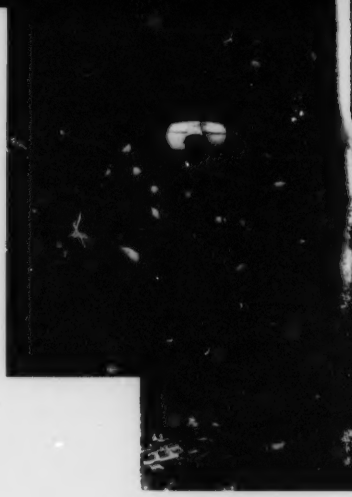
The laboratories include high-voltage test installations capable of reaching voltage levels of ±1200 kV DC or 2100 kV_{rms} AC and produce 5.4 MV impulses for testing external insulation in pollution-free environments, the corona effect, electrical fields, internal insulation (gas, oil or solid) and the contamination of insulators and surge arresters. The high-power laboratory offers the entire range of voltages and powers needed to test present-day systems operating at up to 735 kV, and is used to study various electrical power phenomena such as arcs and short-circuits and their effect on apparatus. Tests include short-circuit and heat-run tests, direct and synthetic tests, cycling tests, and various combinations of electrical tests.

The research institute also has a full range of mechanical, thermomechanical, climatic, cycling and heat-run test stations. The power-system simulation laboratory has two types of simulators (hybrid and digital) and a database obtained from the most sophisticated testing in the world used to perform analyses on automatic controls such as HVDC, static controllers, FACTS and protective relays.

Other installations include the field-testing units, specialized in the *in situ* testing of electrical apparatus and tests aimed at ensuring the safety of the public, workers and equipment, and a calibration and repair laboratory also specialized in measurement and testing.



- High-voltage laboratory
- High-power laboratory
- Mechanical and thermomechanical laboratory
- Power-system simulation laboratory
- Field-testing units
- Calibration and repair laboratory



Generation

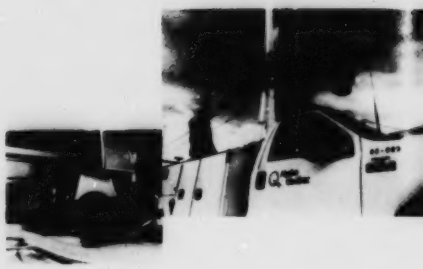
- Embankment dams with a cement concrete flow-retarding facing
- Improving the compressed-concrete concept for the construction of Hydro-Québec's dams
- Optimizing the upgrading of dams and installations: diagnosis, materials and methods
- Developing batteries for emergency systems
- Risk management tools in the area of dam safety
- Underwater robot for the inspection of Hydro-Québec's submerged dams
- Increasing the output of hydraulic turbines (MATH)
- Increasing the service life of generating units
- On-site upgrading of turbine runners
- State-of-the-art remote-monitoring tools for inspecting the condition of generating facilities
- Integrated methodology for generator diagnostics
- Magnetic and superconducting bearings and couplings
- Diagnostic tools and maintenance techniques for Gentilly-2
- Forecasting inflows from the standpoint of the management of major hydrological systems
- Forecasting inflows over the short and medium terms and improving the management of run-of-river installations
- Acquisition, transmission, processing and analysis of hydrometeorological data
- Improving the overall generating-facility planning process
- Optimal planning of generating system outages
- Optimizing the generation of Beauharnois generating station

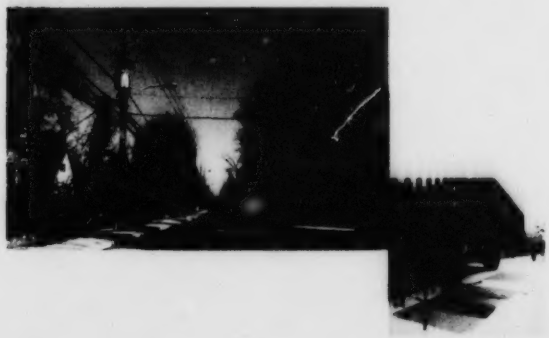
Transmission

- Development and testing of new diagnostic methods for high-voltage circuit breakers
- Developing tools to assess the condition and residual service life of power transformers
- Developing tools to assess the condition and service life of line equipment
- New optimized conductors and bundles
- Using surface foundations on overburden for guyed towers
- Foundations for self-supporting angle and dead-end towers
- New types of foundations for substation equipment
- Improving power system behaviour
- Improving the performance of protection systems
- Assessing the safety of the network in real time
- EMTP man-machine interface
- Real-time simulation tools (Hypersim)
- Maintenance of simulation and analysis tools
- Improving the precision of system control tools as part of market deregulation
- Operational tools for applying efficient and safe de-icing techniques
- System restoration tools
- Finding solutions for the problem of overhead ground wires
- Improving the electrical insulation of substation equipment subject to icing
- De-icing using hot water or vapour
- Photonic de-icer
- Countering the effects of galloping on transmission lines
- Improving the mechanical strength of overhead lines

Distribution

- Optimizing the use of poles: use of protective coatings for steel poles
- Optimizing the use of poles: preserving poles through the use of polymer additives
- Optimizing the use of poles: maintenance program
- Optimizing structures and modular assemblies
- Transformer materials with low magnetic losses through electroforming
- New process for assembling distribution transformers with amorphous cores
- Predictive maintenance for overhead and underground distribution lines
- Diagnostic methods for underground lines
- Automatic distribution system fault locator
- Knowledge of load
- Remote manipulation system for underground maintenance work
- New underground distribution mode using intermediate voltage
- Fault current and energy limiters using superconductor technology
- Fault energy limitation
- Relevance of system data and parameters in a context of automation





Customers

- Speeding up processes involving the production of wood-based panels using dielectric technologies
- Continuous conduction heating of wires
- New applications for electroflotation and its variants
- Electrohydrogenation of food oils
- Azelaic acid
- Integrated heating-ventilation
- Convector
- Electrical gas conversion
- Nanocristalline electrodes
- Plasma-assisted sludge oxidation process
- Thermal storage